Engineering Consequences of changing Traffic Flows on Minor Rural Roads in a developing multifunctional European Countryside

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Abstract

Multifunctional agriculture (MFA) is a leading catchword in European agricultural policy. This paper aims to investigate expanding traffic flows arising from new activities connected with agricultural business, such as on-farm sales of products, care-farming, and agritourism. These activities put an extra burden on the road network additional to flows generated by traditional agricultural activities. Additional volumes can be estimated from general data and depend on the scale of facilities, for example 1.8 vehicle trips per weekday for 1 room in a B&B. The capacity of minor rural roads to bear this extra burden is questionable. To avoid damage to road and/or verge minor roads' capacity limits must be respected. For good engineering solutions we advise careful spatial planning, taking into account road capacity.

Key words: agriculture – road capacity - rural areas – transition – transportation planning

1. Introduction

The European countryside is changing. Within a globalization process agricultural production takes place on a much lager scale than before (Bindraban & Rabbinge, 2011). At the same time and in some areas even simultaneously, the countryside is developing towards a multi-functional space (Jongeneel & Slangen, 2004). Here recreation and agritourism develop on the large scale, generating a various demand from society for new activities in the rural area. Most of these new activities are connected with agricultural business. This multi-functional agriculture (MFA) is a new paradigm, alongside the traditional model of food production, in which agriculture is expected to contribute to various other functions of land use. In Ilbary's words: "[t]he countryside is increasingly an area of consumption as well as production …. Alternative uses of rural space are developing…" (Ilbary, 1998; p.1). Consequently, the countryside faces increasing traffic flows and a wider variation of modes of transport. It is questionable to which extend present road networks, that historically have been developed for agricultural use only can cope with expanding new traffic flows. Moreover as traffic safety on minor rural roads is a point of special concern in general (Jaarsma et al., 2011).

We aim to investigate the consequences of a developing MFA landscape for the engineering design of minor rural roads. We therefore first present our method, with a conceptual model, relating actual developments in agriculture to the generation of traffic. We then explore in the following sections (1) the new functions in a MFA landscape, (2) their traffic generation, and (3) rural road capacity. Finally, a discussion section with conclusions is presented.

2. Method and material

The European Model of Agriculture (EMA) aims to integrate environmental goals into the common European agricultural policy and to develop the 'countryside stewardship' role of

European farmers (Robinson, 2004). Therewith 'multifunctionality' became a leading catchword in EU-agricultural policy. Besides growing food, farmers took up all kinds of non-traditional side activities to increase their revenues (Jongeneel and Slangen, 2004). The widening into MFA within the EMA policy is one possible decision for farmers looking for new financial resources. Other possible decisions to increase their revenues are enlarging of scale and terminating active farming. Figure 1 shows these possible decisions and the related consequences for rural traffic and transportation. As stated in the introduction, these developments in agriculture appear simultaneously.

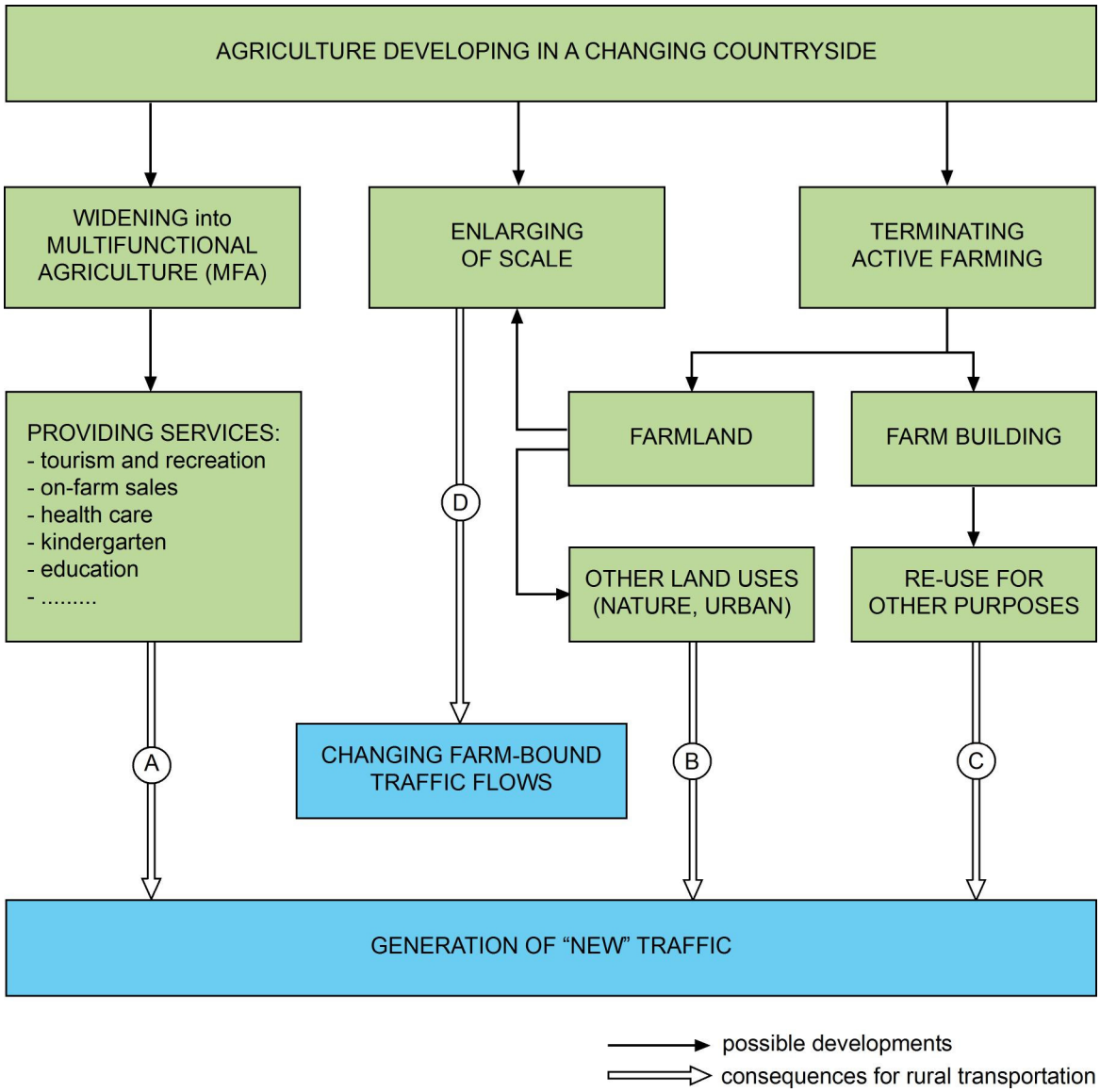

FIGURE 1: Conceptual model
(Adapted from Jaarsma and De Vries, 2012)

The consequences for rural traffic and transportation are quite different for the developments distinguished. In this paper we focus on the consequences of MFA (arrow A in Figure 1). Services are provided by existing farms, to fulfill a societal demand, and so generate new traffic to the farm, additional to the continuing traditional agrarian traffic. This is different from what happens in both other developments. When active farming is terminated, the character of the new land use decides the amount of new traffic to the former farm land and eventually, for example for a reuse as an urban area, a total new road layout has to be constructed

(arrow B). In case of terminating active farming, the farm building generally will be reused for non-agrarian purposes (arrow C). Jaarsma and De Vries (2012) show that this can generate considerable new traffic flows, especially when the new function of the former farm building is a commercial one. Looking at the farmland of farms that have been terminated, statistics show that by far most land remains in agricultural use. In a continuous process of enlarging of scale in agriculture it is added to other farms (arrow D). Rienks et al. (2009) show how a further enlarging of scale in dairy farming will decrease farm-bound traffic with trucks through more efficient external transport, but simultaneously considerably increase agricultural vehicles flows on public roads through longer internal distances within the farm enterprise.

In this paper we explore arrow A in the figure through a study of international literature related to widening and the activities included. To estimate the additional traffic generated by these activities we apply Dutch trip rates, as calculated by CROW (2007 and 2008). This is a well-known method in transportation planning, presenting average daily trip rates per unit (worker, inhabitant, visitor, square meter floor space, etc.) for different land uses and for a wide range of activities. Finally, to investigate to what extent volumes generated can be facilitated by the rural road network we use an approach with Dutch road capacity data for minor roads (CROW, 2002). This approach is based on empirical research in Dutch land development projects to avoid damage to the verge through overloading (Mooy, 1981).

3. Widening: which new functions?

When on farms a new economic function is established in addition to the agrarian function, a double question turns up (1) which additional function is added, and (2) what is its trip generation?.

The European farm model stimulates MFA, with activities such as on-farm sales of products, care-farming, nature management and tourism. In 2009 in the Netherlands on a total of 73,008 agrarian holdings new multifunctional activities were found on 16,263 (22.3%) holdings (www.statline.cbs.nl). Landscape and nature management is the most frequently reported activity (on 5773 holdings), followed by on-farm sales (2252), agritourism (2237) and stabling facilities (2193), either for animals (for example horses) or goods (caravans etc.). 2180 Farm holdings use their machinery to provide contract work on other farms. Other activities of widening are on-farm processing of farm products (on 731 holdings), care-farming (707), farm education (108), and exploring a kindergarten (64).

Not all these new functions on farms cause additional farm-bound traffic flows on public roads. For example, landscape and nature management activities focus on the farmland. Work for this purpose by the farmer may cause some internal traffic on the farm. These activities replace internal traffic for agrarian activities such as mowing. When a farmer is active in contract work for other farmers he will use the public road, but there is no additional traffic, because he is replacing a contractor who would have made the same trip.

For the other additional functions appearing in MFA we will estimate their traffic generation in the next section.

4. Traffic generation

In this section we estimate the additional traffic generation by the new a non-agrarian activities as applied on the farms with MFA. As stated in section 2, trip rates for several economic functions in the Netherlands are given in CROW (2007 and 2008). Trip rates may depend on the location of the activity, either in an urban center, in the outskirts of a town or in a rural area. If available, we use the value given for rural areas. To compare with, for a rural residence a general value of 7.4 is given (CROW, 2007: Table 4, page 19). This value is the average for all days of the week, i.e., 90% of the weekday average of 8.2 trips per residence.

In Table 1, we give an overview, as much as possible combined with the associated trip rates for a location in a rural area given by CROW (2008). Unfortunately, functions such as stabling facilities, care farming, farm education and on-farm processing are not explicitly included in the CROW study. We then present values for a comparable activity.

TABLE 1: Traffic generation for several non-agrarian functions: trip rates (daily number of motor vehicle movements, all days of the week).

Function [1)]	Daily trip generation and unit (movements)	Remarks and sources
On-farm sales	88 motor vehicles per 100 m^2 gross floor space[2)]	Value for a small-scale super market (CROW, 2008; Table 10)
Agro-tourism: - Campsites - B&B	 3.6 per 10 stands 1.8 per room	 CROW (2008); Table 45 CROW (2008); Table 47
Stabling facilities	4 per horse(box)	Riding-schools (CROW, 2008; Table 23)
Care farming	32 motor vehicles per 100 m^2 gross floor space [2)] 26 motor vehicles per 100 m^2 gross floor space	CROW (2008), Table 19 (fitness centre) CROW (2008), Table 51 (family doctor practise, single or multiple)
Farm education	?	No comparable activities
Kindergarten	23.6 motor vehicles per 12.5 children	CROW (2008); Table 62
On-farm food processing	170 cars and 44 trucks per 10,000 m^2	Food manufacturer [3)], generation for mixed commercial areas (CROW, 2007; Table 8)

1) Categories of widening activities on farms as in www.statline.cbs.nl
2) Location on the outskirts of a town; no value is given for a location in a rural area.
3) For these function, only a general value for weekdays is available. Source: CROW (2007).

In conclusion, by analyzing the kind of activities and their dimension on farms with MFA it is possible to estimate the traffic generated by these activities. These are flows additional to the traffic flows by traditional agricultural activities, and so put an extra burden on the road network. Additional flows depend on the scale and type of facilities, for example (expressed in vehicle trips per weekday): riding-schools 4 per horse(box) and B&B 1.8 per room.

5. Road capacity minor rural roads

The rural road network consists of dual carriage motorways, rural highways (one carriageway, two lanes) and minor rural roads (MRRs) with only one lane for two-way traffic and a pavement width between 2.5 and 5.5 m. In the Netherlands, the majority of the MMRs (with a total length of 47,500 km) have a pavement width of less than 4.00 m. The road capacity of MRRs is deciding for the accessibility of farms and, as such, farms with MFA. MRRs show a relatively high risk of casualty accidents (Jaarsma et al., 2011), caused by a mix of road users (cyclists, cars, trucks, and agricultural vehicles) with different speed

profiles and a variation in vehicle masses. Therefore expanding traffic flows on MRRs should be considered very carefully.

As a consequence of small pavement widths on MRRs motor vehicles must use the verge both when encountering and when overtaking each other. The frequency of these events depends on three characteristics; (1) traffic volumes and speeds (deciding the number of encounters and overtaking maneuvers), (2) pavement width (the smaller the pavement, the more frequent the use of the verge), and (3) the proportion of 'wide vehicles' (trucks plus agricultural vehicles) in total traffic on the MRR. Empirical studies by the former Dutch Government Service for Land and Water Use quantified frequencies of acceptable usage levels of the verge, i.e., volumes that do not damage the verge over the long term (Mooy, 1981). These levels are presented in Table 2. They further depend on the load capacity of the subsoil. Therefore, different values appear for areas with solid sandy soils and areas with weaker peat or clay soils. For the pavement width a minimum value of 3.00 m is applied, increasing with incremental steps of 0.50 m to 5.00 m. When volumes exceed the level of a 5.00 m wide MRR, a pavement width of 5.50 or 6.50 m can be applied. Then the capacity level is considerable higher (and independent from the type of soil), because such pavements are wide enough for passing and overtaking without use of the verge.

TABLE 2: Maximum acceptable volumes to avoid damage to the verge (CROW, 2002; AADT, expressed in motor vehicles per day, including 12% trucks and agricultural vehicles).

Pavement width (m)	Volume (motor vehicles per day; average annual daily volume)	
	Soil: sand	Soil: peat or clay
3.00	350	300
3.50	400	350
4.00	575	500
4.50	1,000	800
5.00	1,400	1,150
5.50	3,000 to 4,000	
6.50	5,000 to 6,000	

In conclusion, the verge of MRRs with a pavement width of 5.00 m or less is used for encountering and overtaking of vehicles. Criteria have been developed for acceptable traffic volumes to avoid damage to the verge for a given pavement width (Table 2).

6. Discussion and conclusions

As stated in section 2, in 2009 already more then 20% of Dutch farmers widened their holding with MFA. MFA is fitting in the EU-agricultural policy and it considerably supports income for the farmers. In 2009 36% of Dutch farmers with MFA generated between 10 and 50% of their farm income by these activities, and for 10% this was even more than 50%.

It is important to consider that MFA may generate additional traffic on MRRs with limited capacity. To avoid damaging of verges and related road safety problems on access roads to farms with MFA, a careful planning procedure is advised. In this procedure the consequences of MFA for the engineering design of the access road to the farm are considered. For this purpose first the information on type and dimension of planned activities is gathered. This is the basis for the calculation of the additional traffic generation as explained in section 4. Next this volume is added to the traffic volume in the existing situation (previously obtained with automatic counting devices). Finally this new volume is checked with the capacity values in Table 2, given the pavement width and the soil type for the access

road to the farm with MFA in question. If the new volume is lower than the capacity value, the engineering design of the access road is sufficient for starting the new activities.

However, if the new volume exceeds the capacity value of the access road, its engineering design has to be adapted before starting the new activities. In theory it is possible to do so by widening of the road, but also other options should be considered. For example, a traffic calming scheme (Jaarsma, 2000) with a concentration of through traffic on a limited number of roads, suitable for somewhat higher volumes and leaving the other MRRs for access only may create circumstances with enough road capacity for a MFA. Traffic calming also improves the attractiveness of the multi-functional rural area for recreation and agritourism, which, in turn, supports several types of MFA.

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